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Lashmore et al.

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[54] **ACID ASSISTED COLD WELDING AND INTERMETALLIC FORMATION AND DENTAL APPLICATIONS THEREOF**

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[56] **References Cited**

U.S. PATENT DOCUMENTS

Re. 29,093	12/1976	Burns	264/111
2,040,179	5/1936	Livingstone et al.	148/513
3,004,332	10/1961	Werner	29/182.5
3,914,507	10/1975	Fustukian	428/404
3,933,961	1/1976	Burns	264/111
4,181,757	1/1980	Youdelis	427/229
4,218,507	8/1980	Deffeyes et al.	428/328
4,235,631	11/1980	Aliotta et al.	148/513 X

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

0 291944	11/1988	European Pat. Off. .
2 216 545	10/1989	United Kingdom .

OTHER PUBLICATIONS

PCT/US94/11312, International Search Report.

Goetzel, C. G., "Treatise on Powder Metallurgy", pp. 248–250, 1949, vol. 1, Technology of Metal Powders and Their Products.

(List continued on next page.)

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[57] **ABSTRACT**

A metallic composite solid, containing alloys and/or intermetallics, is formed by compacting at moderate pressure a mixture of powder particles, foils or sheets at a temperature close to room temperature, well below the melting temperature of the constituent components and without the addition of low melting metals such as mercury, indium or gallium acting as a sintering agent. This low temperature consolidation of the powder mixture is enhanced by having the surface oxide of the powder particles removed, prior to consolidation, and/or by coating the particles with an oxide-replacing metal such as silver or gold. The coating process may be replacement reactions, autocatalytic reduction or electrolytic reduction. The composite formation is assisted by the addition of a liquid acid such as fluoroboric acid, sulfuric acid, fluoric acid, adipic acid, ascorbic acid, or nitric acid. A preferred embodiment of the process for metal solid composite formation is a process for forming dental restorative materials at ambient temperatures and under pressure exerted by manual dental instrumentation.

27 Claims, 20 Drawing Sheets